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A SECOND LOOK AT THE ROLES OF QUIT RATES AND EXCEPTIONAL VARIABLES IN THE DETERMINATION OF MONEY WAGES

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In his recent discussion of wage-determination in the U.S. manufacturing industry and its durable and non-durable components, Arthur Donner[1] attempts to explore the short-run interaction of labour turnover and inflationary expectations by incorporating this interaction into "a two-equation model suitable for econometric testing". His tentative conclusions concern both the direct roles of these variables and the speeds of adjustment of wage changes to prior expectational changes. Unfortunately, although this discussion contains sufficient references to the Koyck transformation and the Yule-Slutsky effect, the technique of estimation which is used by Donner does not take account of their consequences. In particular, a clear case can readily be established for the proposition that most of his estimates are neither unbiased nor consistent. Appropriate correctional adjustments can be made and we use these to re-assess the relevance of Donner's conclusions.

Since theoretical analyses cannot establish the quantitative significance of biases and false inferences, our numerical results provide important evidence with respect to the robustness of Donner's estimates. They appear to confirm a significant role for excess demand, as represented by quit rates, in the determination of money wage changes but the effect of inflationary price expectations remains uncertain in the absence of prior information with respect to the speeds of adjustment to such expectations. In his list of tentative conclusions[2], Donner cites one particular result which he had not anticipated. "The implication that the wholesale price index fits the estimating equation slightly better than consumer prices is somewhat startling at first, but may present some support for the hypothesis that prices and wages are raised when labour supply tightens--and particularly when vacancies rise above their steady-state values. There appears to be some tentative support in these findings for the hypothesis that the money illusion exists in the short run." Our results suggest that the use of the wholesale price index (WPI) leads to substantially better fits than the use of the consumer price index (CPI) for both total manufacturing and its separate components. Donner's least-squares estimates of the coefficients for the CPI variable and their associated Student's t-statistics are markedly biased. Finally, a model which contains the unusual specification of wage expectations as an explanatory variable for money wage changes is conclusively rejected by our results. This confirms another of Donner's conclusions.

Two Expectational Models of Wage Determination with Quit Rates

We shall use the following notation: w_t = percentage annual rate of change in money wages at time t; x_t = measure of excess demand for labour at time t; p_t = percentage annual rate of change in an index of prices at time t; δ = coefficient of adaptive expectations (with subscripts denoting different expectational models); and s and r are positive integers which represent the quarterly extent of informational or predictive lags. An asterisk is used to distinguish expected (or anticipated) values of variables from actual values. Thus, w_t^* is the percentage annual rate of change in money wages expected for the t-th time period, where this expectation is formed in the (t-s)-th time period. Similarly, p_t^* is the percentage annual rate of change in a price index expected for the t-th time period, where this expectation is formed in the (t-r)-th time period.

These expectations are assumed to be generated by simple adaptive mechanisms of the following type.

$$(1) \quad w_t^* = w_{t-s}^* + \delta_1(w_{t-s} - w_{t-s}^*)$$

$$(2) \quad p_t^* = p_{t-r}^* + \delta_2(p_{t-r} - p_{t-r}^*)$$

Such mechanisms have enjoyed widespread use in empirical analyses although their bases[3] are "more or less ad hoc". The two expectational lags and coefficients of adaptive expectations are assumed to be constant in the post-war U.S. economy. Donner sets unit values for the expectational lags but we consider values consistent with both quarterly and annual lags. The motivation for inclusion of annual lags as well as quarterly lags is determined by consideration of the vital role of bargaining groups in the labour market, which is discussed in a later section.

The influence of excess demand for labour can be combined with the influence of these expectational variables in order to derive two distinct models of wage-determination, which may be distinguished by their particular choice of expectational variable; namely, the "wage-expectations" hypothesis

$$(3) \quad w_t = \alpha_0 + \alpha_1 x_t + \alpha_2 w_t^*$$

and the alternative "price-expectations" hypothesis

$$(4) \quad w_t = \alpha_3 + \alpha_4 x_t + \alpha_5 p_t^* ,$$

where the undefined symbols represent unknown parameters. Donner identifies these formulations with theoretical models due to Friedman and Phelps, and Phelps, respectively, and, for the sake of brevity, we shall not repeat his account[4]. The reduced forms for the two models are

$$(5) \quad w_t = \alpha_0\delta_1 + \alpha_1 x_t - \alpha_1(1-\delta_1)x_{t-s} + (\alpha_2\delta_1 + 1 - \delta_1)w_{t-s}$$

$$(6) \quad w_t = \alpha_3\delta_2 + \alpha_4 x_t - \alpha_4(1-\delta_2)x_{t-r} + \alpha_5\delta_2 p_{t-r} + (1-\delta_2)w_{t-r} .$$

If additive random errors are introduced in these equations, their unknown parameters can be estimated. Least-squares estimates are presented in Tables 1 and 2. The main parts of these tables contain parametric estimates and, in parentheses, their associated Student's t-statistics under the hypotheses that individual parameters are zero. The latter statistics are based on the classical assumptions that the errors are homoscedastic and free from autocorrelation. (The presence of a lagged dependent variable in each formulation implies that the statistics will only have asymptotic validity.)

Estimates for the structural parameters can be derived from the least-squares estimates of regression coefficients and these are presented in the lower portions of the two tables. With the price-expectations hypothesis, the structural parameters are over-identified and this leads to difficulties in interpretation when two estimates of the same parameter are substantially different. We shall find that these difficulties are common and do not disappear when consistent and more (asymptotically) efficient estimates are derived in a later section. These tables are completed by values for the adjusted coefficients of multiple determination ($\bar{R}^2$), Durbin-Watson statistics, and other statistics which are distributed as Fisher's F with (5, 65) degrees of freedom for the price-expectations model but with (4, 66) degrees of freedom for the wage-expectations model for both lengths of expectational lags. These F statistics may be associated, in the assumed conditions, with tests of the hypotheses that all of the regression coefficients in particular equations are equal to zero. The coverage of the data extends from the first quarter of 1948 to the second quarter of 1965 inclusive.

Although the fits of the regression coefficients in Table 1(A) appear

Table 1(A). Wage-Expectations Model (OLS Estimates), Quarterly Lag[5]

	TOTAL MANUF. (5a)	DURABLE (5b)	NON-DURABLES (5c)
Constant	0.1529 (0.535)	0.0165 (0.047)	0.3842 (1.5865)
Quits (t)	5.0918 (7.757)	5.5039 (6.740)	3.3217 (6.409)
Quits (t-1)	-4.1600 (-7.488)	-4.3132 (-6.277)	-2.8441 (-5.881)
Wages (t-1)	0.5668 (7.022)	0.4990 (5.373)	0.6824 (9.597)
F	599.6	418.9	669.7
$\bar{R}^2$	0.86	0.81	0.85
D.W.	1.85	1.76	2.17
δ_1	0.183	0.216	0.144
α_0	0.836	0.076	2.672
α_1	5.092	5.504	3.322
α_2	-1.367	-1.316	-1.209

Table 1(B). Wage-Expectations Model (OLS Estimates), Annual Lag

	TOTAL MANUF. (5d)	DURABLE (5e)	NON-DURABLES (5f)
Constant	-0.1588 (-0.384)	-0.4247 (-0.997)	0.7930 (2.142)
Quits (t)	3.5616 (12.060)	3.6570 (11.662)	2.5821 (9.850)
Quits (t-4)	-0.8642 (-2.544)	-0.2003 (-0.583)	-1.3381 (-4.502)
Wages (t-4)	-0.1172 (-1.229)	-0.3619 (-3.616)	0.2330 (2.983)
F	291.1	273.5	311.9
$\bar{R}^2$	0.72	0.72	0.68
D.W.	0.59	0.69	0.72
δ_1	0.757	0.945	0.4818
α_0	-0.210	-0.449	1.646
α_1	3.562	3.657	2.582
α_2	-0.475	-0.441	-0.592

Table 2(A): Price-Expectations Model (OLS Estimates), Quarterly Lag[6]

	TOTAL MANUF.		DURABLES		NON-DURABLES	
	(6a)	(6b)	(6c)	(6d)	(6e)	(6f)
Constant	0.3893 (1.339)	0.5420 (1.961)	0.3133 (0.877)	0.4259 (1.226)	0.5168 (1.873)	0.9910 (3.688)
Quits (t)	5.1260 (8.117)	4.7195 (7.859)	5.4378 (6.948)	4.9798 (6.469)	3.2177 (6.087)	2.3589 (4.449)
Quits (t-1)	-4.1477 (-7.762)	-3.5106 (-6.650)	-4.2979 (-6.528)	-3.6812 (-5.572)	-2.7280 (-5.486)	-1.5786 (-2.899)
CPI (t-1)	0.1485 (2.518)		0.1733 (2.629)		0.0596 (1.002)	
WPI (t-1)		0.1255 (3.977)		0.1216 (3.492)		0.1371 (3.916)
Wages (t-1)	0.4250 (4.431)	0.3114 (3.205)	0.3771 (3.758)	0.3181 (3.172)	0.6152 (6.296)	0.3393 (3.120)
F	519.8	590.6	366.5	394.4	536.0	655.2
$\bar{R}^2$	0.87	0.89	0.83	0.84	0.85	0.87
D.W.	1.75	1.78	1.72	1.70	2.00	1.71
δ_2^1	0.575	0.689	0.623	0.682	0.385	0.661
α_3^1	0.677	0.787	0.503	0.624	1.343	1.500
α_5^1	0.258	0.182	0.278	0.178	0.155	0.208
δ_2^2	0.191	0.256	0.210	0.261	0.152	0.331
α_3^2	2.040	2.116	1.495	1.633	3.396	2.996
α_5^2	0.778	0.490	0.827	0.466	0.392	0.414
α_4	5.126	4.720	5.438	4.980	3.218	2.359

Table 2(B): Price-Expectations Model (OLS Estimates), Annual Lag

	TOTAL MANUF.		DURABLES		NON-DURABLES	
	(6g)	(6h)	(6i)	(6j)	(6k)	(6l)
Constant	0.4199 (0.951)	0.9945 (2.441)	0.2987 (0.640)	0.6561 (1.442)	0.3953 (0.953)	0.9725 (2.051)
Quits (t)	3.5154 (12.519)	3.2611 (12.861)	3.5764 (12.051)	3.3927 (11.878)	2.6421 (10.225)	2.5173 (8.864)
Quits (t-4)	-0.8048 (-2.491)	-0.2332 (-0.758)	-0.3781 (-1.148)	-0.1106 (-0.361)	-1.4619 (-4.911)	-1.1905 (-3.098)
CPI (t-4)	0.2005 (2.870)		0.1858 (3.046)		-0.1576 (-1.969)	
WPI (t-4)		0.1800 (5.391)		0.1240 (4.292)		0.0320 (0.610)
Wages (t-4)	-0.3518 (-2.885)	-0.6027 (-5.008)	-0.5024 (-4.784)	-0.5839 (-5.671)	0.4360 (3.397)	0.1381 (0.793)
F	260.1	337.7	248.1	280.2	261.2	247.2
$\bar{R}^2$	0.75	0.80	0.75	0.78	0.69	0.68
D.W.	0.65	0.82	0.77	0.91	0.99	0.66
δ_2^1	1.352	1.603	1.502	1.584	0.564	0.962
α_3^1	0.311	0.620	0.199	0.414	0.701	0.101
α_5^1	0.148	0.112	0.124	0.078	-0.279	0.033
δ_2^2	0.771	0.929	0.894	0.968	0.447	0.527
α_3^2	0.545	1.071	0.334	0.678	0.885	1.845
α_5^2	0.260	0.194	0.208	0.128	-0.353	0.607
α_4	3.515	3.261	3.576	3.393	2.642	2.517

to be excellent, the derived estimates for the structural parameter α_2, which corresponds to the wage-expectations variables, are negative and contrary to a priori notions. This problem persists in Table 1(B) when the duration of the adjustment lag is lengthened to four quarters. Thus, modifications to the expectational mechanism do not appear to be sufficient to resolve the problem. This introduces grave doubts about the wage-expectations model which, however, might be eliminated by the use of arguments asserting that the least-squares are biased and, thus, unreliable. These arguments are predicated on the presence of both unrecognized autocorrelation and lagged dependent variables. They might be encouraged in the model with an annual lag by low values of the D.W. statistics. We demonstrate in the next section that the doubts persist even when the presence of autocorrelation of a particular type is explicitly recognized.

The problem of a negative estimate for the regression coefficient of the expectational variable is not present in either Table 2(A) or 2(B) for the price-expectations model but two other problems of interpretation arise. One of these problems is readily avoided by a particular choice for the expectational lag but the other problem, which was not recognized by Donner, is a major one of overdetermination and pre-occupies much of the exposition given below. If we consider only the regression coefficients in these tables, there appears to be little basis for choice between the two expectational lags especially if we remember that test statistics based on both of the quits variables are more appropriate than individual t-statistics. Similarly, as cited in our introductory comments, there is little basis for discrimination between the CPI and WPI variables.

The principal problem with the price-expectations model is apparent as soon as the derived estimates for the structural parameters are considered. It is clear from the form of equation (6) that two estimates of the coefficient of adaptive expectations δ_2 can be derived from the estimated regressive coefficients. The first estimate is based solely on the coefficient for the lagged wage variable whereas the second is based upon the ratio of the coefficients for the two quits variables. These estimates are distinguished in the tables by superscripts and, since they are both consistent if the model is free from mis-specification, neither is clearly superior to the other. Donner[7] considers only δ_2^1 (based on the coefficient of the lagged wage variable) and asserts "The coefficient of response to the price expectations variable may range anywhere between 0.2 and 0.6, depending on which excess demand proxy one chooses in the wage determination equation. This would provide some support for a rather short response to anticipations, two to five quarters". Our results indicate that the two estimates δ_2^1 and δ_2^2 are so different within each equation as to provide no information about the size of this parameter. Values exceeding unity are indicated for total manufacturing and durable manufacturing and these, coupled with prior notions concerning the lag of wages to price anticipations, might suggest that the model with an annual lag be rejected. However, the other estimate δ_2^2 for this model would not indicate rejection.

Since distinct estimates of the other structural parameters α_3 and α_5 are based on the two values of the adjustment coefficient, any difficulty with its estimation will affect their estimation also. Comparison of the entries in the lower portions of the two tables indicate very marked differences between estimates of both α_3 and α_5. In particular, for the model with a quarterly expectational lag, derived estimates for the parameter associated with the price variable range between 0.155 and 0.827. Variations in estimates are substantially greater within any equation through alternative choices of δ_2 than between total manufacturing and its two components. Clearly, any conclusions which are derived from these tables and concern the presence of money illusion in the money market are ambiguous. If the errors for the price-expectations model were autocorrelated, differences between estimates of any particular parameter might be explained in terms of the statistical inadequacies of the least-squares technique and it is to this explanation that we now turn.

Bargaining Groups and Autocorrelation

As a preliminary to the adoption of the least-squares technique to estimate the coefficients of the final-form equations, additive errors were introduced into these equations and these errors were assumed to be free from autocorrelation. More appropriate specifications might require the introduction of additive errors into one or more of the structural equations. In his seminal exposition[8], Koyck pointed out that, if the original errors for structural equations were independent, the use of his transformation would result in the autocorrelation of errors in the final-form equations. He indicated the presence of biases, which persist even with large samples, in the least-squares estimates of coefficients for the final-form equations. These biases are due to the presence of both a lagged dependent variable and autocorrelated errors.

Although Koyck suggested a method which eliminates biases for large samples, his method is cumbersome and it depends critically on the assumption that the structural errors are independent. Consequently, we chose to use the simpler instrumental-variable technique which enjoys the advantages of the Koyck method but is not affected adversely by such autocorrelated structural errors. Estimates based on this technique are presented in Tables 3(A) and 3(B) for the price-expectations model with quarterly and annual expectational lags respectively. Similar estimates were calculated for the wage-expectations model but are not presented here since they indicate unacceptable derived values for α_2, the parameter associated with the wage-expectations variable. These were {-1.391, -1.391, -1.461} for the quarterly-lag model and {-0.4396, -0.4577, -0.1479} for the annual-lag model.

The instrumental-variable estimates, which are based upon the use of an additional lagged quits variable as an appropriate instrumental variable, should be compared with least-squares estimates. They indicate that the price-expectations model with an annual expectational lag is inadequate for the non-durable sector because of the unacceptable derived values for the adjustment parameter δ_2. Note that the least-squares estimates would have led to rejection of this formulation on different grounds for, although the two least-squares estimates of δ_2 in (6k) of Table 2(B) are quite similar, the derived values for α_5 are both negative. The problem of markedly different estimates for δ_2 persists even though all these estimates are consistent. However, both instrumental-variable estimates δ_2^1 and δ_2^2 exceed unity for the model with an annual expectational lag and these results suggest that this model should also be rejected for both total manufacturing and durable manufacturing.

If comparisons are restricted to the price-expectations model with a quarterly expectational lag, then the two sets of estimates for both regression coefficients and structural parameters are very similar. Attention should therefore be shifted to inferential deficiencies which arise because of biases in the calculation of t-statistics for the least-squares fits. These biases

Table 3(A). Price-Expectations Model (IV Estimates), Quarterly Lag

	TOTAL MANUF.		DURABLES		NON-DURABLES	
	(6a)	(6b)	(6c)	(6d)	(6e)	(6f)
Constant	0.3871	0.5456	0.2774	0.4028	0.4206	1.0367
Quits (t)	5.2260	4.7525	5.8063	5.3384	3.2130	2.3018
Quits (t-1)	-4.1704	-3.4968	-4.4124	-3.6860	-2.8735	-1.4635
CPI (t-1)	0.1629		0.2081		0.0112	
WPI (t-1)		0.1305		0.1493		0.1482
Wages (t-1)	0.3855	0.2885	0.2624	0.1637	0.7320	0.2968
δ_2^1	0.614	0.711	0.738	0.836	0.268	0.703
α_3^1	0.630	0.767	0.376	0.482	1.570	1.474
α_5^1	0.265	0.183	0.282	0.179	0.042	0.211
δ_2^2	0.202	0.264	0.240	0.310	0.106	0.364
α_3^2	1.917	2.065	1.156	1.301	3.980	2.846
α_5^2	0.806	0.494	0.867	0.482	0.106	0.407
α_4	5.226	4.752	5.806	5.338	3.213	2.303

Table 3(B). Price-Expectations Model (IV Estimates), Annual Lag

	TOTAL MANUF. (6a)	TOTAL MANUF. (6b)	DURABLES (6c)	DURABLES (6d)	NON-DURABLES (6e)	NON-DURABLES (6f)
Constant	0.6418	1.4259	0.4452	0.9237	10.9302	-3.0405
Quits (t)	3.5748	3.1487	3.6131	3.3529	0.9123	4.1958
Quits (t-4)	0.1154	0.8606	0.2368	0.6380	18.2854	-7.1993
CPI (t-4)	0.4252		0.2766		6.9962	
WPI (t-4)		0.2991		0.1787		-0.8629
Wages (t-4)	-0.9370	-1.1803	-0.8582	-0.9719	-13.8497	3.4665
δ_2^1	1.937	2.180	1.858	1.972	14.850	-2.467
α_3^1	0.331	0.654	0.240	0.469	0.736	1.233
α_5^1	0.220	0.137	0.149	0.091	0.471	0.350
δ_2^2	1.032	1.273	1.066	1.190	21.043	-0.716
α_3^2	0.622	1.120	0.418	0.776	0.519	4.248
α_5^2	0.412	0.235	0.260	0.150	0.033	1.206
α_4	3.575	3.149	3.613	3.353	0.912	4.196

are affected by both the Koyck transformation and the Yule-Slutsky effect. The latter can be attributed to the choice of forms for both the dependent variable and the explanatory variables. We followed Donner's lead and specified the dependent variable in terms of the proportional annual change in wages whereas all explanatory variables were in terms of simple fourth-order moving averages. The basis for these choices is given by George Perry[9] in terms of bargaining groups and annual contractual revisions and they appear to represent the contemporary paradigm for models of wage-determination despite the recent critical comments of Black and Kelejian.[10] We have explored this basis at length elsewhere[11] and have shown that, when viewed as a solution to the discontinuities in temporal bargaining patterns, this form of aggregation leads to the Yule-Slutsky effect upon the errors. That is, the errors for the structural equations must be seen as moving-averages of the errors for four distinct bargaining groups. The weights for the moving-averages of errors and explanatory variables are identical so that the final errors for the reduced-form equations will involve a mixture between the moving-averages of the Yule-Slutsky effect and the autoregression of the Koyck transformation but this mixture will depend only upon the unknown adjustment coefficient δ_2.

More efficient estimates can be derived, in the absence of prior knowledge with respect to the adjustment coefficient, if the method of "feasible" generalized least-squares is used to estimate the regression coefficients. This entails a two-stage procedure whereby instrumental-variable estimates of δ_2 are first calculated and used with the equal weights for the bargaining groups to construct an approximate dispersion matrix for the structural errors. Secondly, Aitken's technique of generalized least-squares is used to estimate regression coefficients with this approximation embodied in the technique instead of the unknown dispersion matrix. Table 4 contains some results for the price-expectations model with a quarterly lag. The table is divided into two parts according to the choice of instrumental-variable estimate of δ_2 that is used in the second stage of the GLS procedure. Parametric estimates and approximate t-statistics are recorded as are the familiar F statistics and Durbin-Watson statistics. An additional collection of statistics are denoted by t(1). These provide appropriate t-statistics for the hypotheses that the coefficients of the price-expectations variable, which are identified with α_5, have unit values.

The role of excess demand, as represented by the quits variable, in the determination of wages is clearly established by these more efficient results since the parameter α_4 fails to be significantly different from zero (at conventional levels) in only one of the twelve estimated equations. Further, if we ignore the worst fit, its estimates are reasonably stable within the range 1.34 to 2.12. In the choice between the two price variables, the WPI specification is clearly empirically superior in equations (6b), (6d) and (6f) to the CPI variable in equations (6a), (6c) and (6e). In fact the estimated coefficient for the price variable α_5 is negative in three equations which used CPI. In all cases, the price variable's coefficient is significantly less than unity. Values for the Durbin-Watson statistics are difficult to interpret in this framework but the high values recorded for non-durables manufacturing might suggest the presence of implicit spillover effects[12] between the bargaining groups over whom the moving-averages have been defined. This presence would imply an additional source of autocorrelation in the structural errors which has been ignored.

Our problem of over-determination is especially relevant in the context

Table 4. Price-Expectations Model (Feasible GLS Estimates), Quarterly Lag

	TOTAL MANUF. (6a)	TOTAL MANUF. (6b)	DURABLES (6c)	DURABLES (6d)	NON-DURABLES (6e)	NON-DURABLES (6f)
δ_2^1	0.615	0.712	0.738	0.836	0.268	0.703
Constant $[\alpha_3]$	0.8594 (0.901)	1.2644 (1.345)	0.5182 (0.441)	1.0803 (0.943)	1.4565 (1.608)	1.9236 (2.373)
Quits $[\alpha_4]$	1.4996 (2.720)	1.4241 (2.940)	1.7309 (2.586)	1.5879 (2.717)	1.3456 (2.427)	0.9386 (2.246)
Prices $[\alpha_5]$	0.2624 (1.699)	0.1866 (2.706)	0.3125 (1.739)	0.2271 (2.888)	-0.1207 (-0.588)	0.1711 (2.864)
t(1)	-4.777	-11.797	-3.825	-9.827	-5.456	-13.877
F	63.7	71.4	48.4	55.3	46.1	78.7
D.W.	2.25	2.45	2.07	2.19	2.66	2.96
δ_2^2	0.202	0.264	0.240	0.310	0.106	0.364
Constant $[\alpha_3]$	0.5041 (0.500)	1.1293 (1.066)	0.3486 (0.280)	1.2903 (1.009)	1.9322 (1.965)	2.0327 (2.214)
Quits $[\alpha_4]$	2.1171 (3.392)	1.4380 (2.411)	2.0107 (2.628)	1.3678 (1.934)	2.0464 (3.490)	0.8333 (1.668)
Prices $[\alpha_5]$	-0.2043 (-0.763)	0.1666 (1.288)	0.0705 (0.235)	0.2836 (2.018)	-1.0996 (-2.946)	0.1389 (1.514)
t(1)	-4.497	-6.442	-3.105	-5.096	-5.730	-9.591
F	42.51	48.27	32.71	39.10	31.90	55.36
D.W.	2.23	2.22	1.99	2.01	2.85	2.75

of Table 4. All of the estimates in both parts of the table are consistent, given the assumptions that we have made, yet we cannot use them to discriminate between the two estimates of the adjustment coefficient.[13] This problem can only be resolved by the availability of prior information with respect to this parameter. This information permits the use of exact generalized least-squares as shown in the various parts of Table 5. We have tabulated estimates for ten different assumed values of the parameter (in one case, twenty) for each of the six price-expectations equations. Approximations can readily be made for intermediate values. Notice that, even if this information is not available, the entries in this table do suggest that the role of excess demand (quits) can be accepted with reasonable certainty. Further, these entries suggest the critical role of the adjustment parameter for inferences concerning the relevance of the price variable. There are values of this parameter δ_2 for which the price variable is an obvious candidate for inclusion in the explanation of wage changes. In particular, high values of δ_2 are more compatible with this inclusion. These values imply myopic expectations in the sense that very large weights are accorded to recent levels and small weights are accorded to historical levels.

Several other comments can be made on the basis of the GLS entries in Table 5 and a comparison of these entries with the least-squares estimates in Table 2(A). Firstly, in Table 5, the estimates of both the parameter of the quits variable α_4 and its associated t-statistic show remarkable stability for both total manufacturing and its durable component when δ_2 exceeds 0.2. This robustness also extends to cases with δ_2 exceeding units (Table 5(B)) which were explicitly excluded in our earlier discussion. In these cases, the resolved form of the adaptive expectations mechanism involves weights

Table 5(A). Regression 6a (GLS Estimates)

δ_2	Constant	$[\alpha_3]$	Quits	$[\alpha_4]$	CPI	$[\alpha_5]$	F	D.W.
0.1	0.094	(0.87)	2.489	(3.90)	-0.792	(-1.88)	31.3	2.33
0.2	0.100	(0.50)	2.127	(3.41)	-0.213	(-0.79)	42.4	2.23
0.3	0.183	(0.61)	1.832	(3.01)	0.028	(0.13)	48.8	2.20
0.4	0.297	(0.75)	1.647	(2.79)	0.153	(0.83)	54.4	2.20
0.5	0.413	(0.85)	1.545	(2.71)	0.222	(1.32)	59.2	2.22
0.6	0.518	(0.90)	1.500	(2.70)	0.258	(1.66)	63.2	2.24
0.7	0.605	(0.91)	1.492	(2.76)	0.276	(1.88)	66.4	2.27
0.8	0.672	(0.90)	1.507	(2.85)	0.281	(2.03)	68.8	2.29
0.9	0.722	(0.86)	1.536	(2.96)	0.280	(2.12)	70.7	2.31
1.0	0.757	(0.82)	1.572	(3.09)	0.274	(2.18)	72.3	2.32

Table 5(B). Regression 6b (GLS Estimates)

δ_2	Constant	$[\alpha_3]$	Quits	$[\alpha_4]$	WPI	$[\alpha_5]$	F	D.W.
0.1	0.018	(0.17)	2.155	(3.22)	-0.140	(-0.51)	28.8	2.19
0.2	0.162	(0.75)	1.641	(2.62)	0.105	(0.66)	42.2	2.18
0.3	0.363	(1.16)	1.400	(2.41)	0.174	(1.49)	51.1	2.24
0.4	0.543	(1.35)	1.328	(2.44)	0.195	(2.04)	58.3	2.31
0.5	0.688	(1.41)	1.332	(2.58)	0.199	(2.39)	63.9	2.37
0.6	0.803	(1.40)	1.368	(2.74)	0.195	(2.60)	68.1	2.42
0.7	0.891	(1.35)	1.418	(2.92)	0.187	(2.70)	71.1	2.45
0.8	0.954	(1.28)	1.476	(3.09)	0.177	(2.72)	73.1	2.47
0.9	0.998	(1.20)	1.535	(3.26)	0.166	(2.70)	74.4	2.48
1.0	1.027	(1.11)	1.591	(3.41)	0.155	(2.65)	75.3	2.48
1.1	0.951	(1.03)	1.643	(3.55)	0.145	(2.59)	76.0	2.48
1.2	0.882	(0.96)	1.690	(3.68)	0.135	(2.54)	76.6	2.48
1.3	0.817	(0.89)	1.734	(3.80)	0.126	(2.48)	77.2	2.47
1.4	0.752	(0.82)	1.777	(3.92)	0.117	(2.42)	77.8	2.47
1.5	0.680	(0.75)	1.823	(4.05)	0.108	(2.35)	78.4	2.46
1.6	0.590	(0.65)	1.879	(4.22)	0.098	(2.25)	79.3	2.44
1.7	0.465	(0.52)	1.954	(4.46)	0.086	(2.12)	80.9	2.39
1.8	0.266	(0.31)	2.068	(4.88)	0.071	(1.98)	84.5	2.30
1.9	-0.024	(-0.03)	2.226	(5.68)	0.060	(2.18)	93.0	2.15
2.0	-0.127	(-0.17)	2.262	(6.45)	0.080	(4.15)	104.7	2.09

Table 5(C). Regression 6c (GLS Estimates)

δ_2	Constant	$[\alpha_3]$	Quits	$[\alpha_4]$	CPI	$[\alpha_5]$	F	D.W.
0.1	0.056	(0.42)	2.345	(2.96)	-0.382	(-0.73)	21.6	2.02
0.2	0.064	(0.26)	2.097	(2.72)	-0.003	(-0.01)	30.5	2.00
0.3	0.128	(0.34)	1.883	(2.50)	0.161	(0.61)	35.5	1.99
0.4	0.212	(0.43)	1.754	(2.40)	0.246	(1.07)	39.5	2.00
0.5	0.292	(0.48)	1.692	(2.38)	0.292	(1.40)	42.8	2.02
0.6	0.355	(0.49)	1.676	(2.42)	0.314	(1.62)	45.6	2.04
0.7	0.397	(0.48)	1.691	(2.50)	0.322	(1.76)	47.8	2.06
0.8	0.418	(0.45)	1.726	(2.61)	0.319	(1.84)	49.7	2.08
0.9	0.423	(0.41)	1.770	(2.74)	0.310	(1.88)	51.2	2.10
1.0	0.418	(0.37)	1.817	(2.87)	0.295	(1.89)	52.4	2.12

Table 5(D). Regression 6d (GLS Estimates)

δ_2	Constant	$[\alpha_3]$	Quits	$[\alpha_4]$	WPI	$[\alpha_5]$	F	D.W.
0.1	0.032	(0.25)	1.911	(2.35)	0.176	(0.53)	21.4	1.96
0.2	0.191	(0.73)	1.531	(2.01)	0.268	(1.37)	32.0	1.97
0.3	0.382	(0.99)	1.374	(1.93)	0.284	(1.97)	38.6	2.01
0.4	0.550	(1.11)	1.343	(2.00)	0.281	(2.39)	43.7	2.05
0.5	0.687	(1.14)	1.366	(2.14)	0.274	(2.67)	47.7	2.09
0.6	0.791	(1.12)	1.415	(2.30)	0.264	(2.84)	50.9	2.12
0.7	0.862	(1.06)	1.481	(2.47)	0.250	(2.92)	53.3	2.15
0.8	0.900	(0.98)	1.557	(2.65)	0.234	(2.92)	54.9	2.18
0.9	0.908	(0.88)	1.638	(2.83)	0.215	(2.83)	55.9	2.20
1.0	0.890	(0.78)	1.720	(3.00)	0.194	(2.69)	56.3	2.21

Table 5(E). Regression 6e (GLS Estimates)

δ_2	Constant	$[\alpha_3]$	Quits	$[\alpha_4]$	CPI	$[\alpha_5]$	F	D.W.
0.1	0.204	(2.05)	2.079	(3.54)	-1.189	(-3.07)	31.1	2.86
0.2	0.284	(1.55)	1.601	(2.82)	-0.369	(-1.51)	41.2	2.71
0.3	0.445	(1.65)	1.270	(2.32)	-0.050	(-0.26)	48.4	2.65
0.4	0.629	(1.79)	1.083	(2.07)	0.110	(0.67)	55.5	2.64
0.5	0.810	(1.90)	0.990	(1.97)	0.198	(1.34)	62.3	2.64
0.6	0.977	(1.96)	0.953	(1.98)	0.247	(1.83)	68.5	2.65
0.7	1.124	(1.98)	0.953	(2.05)	0.273	(2.17)	73.9	2.66
0.8	1.247	(1.96)	0.979	(2.17)	0.284	(2.40)	78.5	2.67
0.9	1.343	(1.90)	1.024	(2.33)	0.286	(2.56)	82.3	2.68
1.0	1.408	(1.82)	1.082	(2.52)	0.281	(2.66)	85.5	2.68

Table 5(F). Regression 6f (GLS Estimates)

δ_2	Constant	$[\alpha_3]$	Quits	$[\alpha_4]$	WPI	$[\alpha_5]$	F	D.W.
0.1	0.078	(0.79)	1.816	(2.89)	-0.422	(-1.65)	26.4	2.57
0.2	0.298	(1.50)	1.167	(2.02)	-0.013	(-0.09)	39.1	2.59
0.3	0.577	(2.03)	0.891	(1.69)	0.107	(1.00)	49.4	2.69
0.4	0.821	(2.28)	0.827	(1.70)	0.149	(1.74)	58.4	2.78
0.5	1.023	(2.37)	0.845	(1.85)	0.164	(2.24)	66.2	2.85
0.6	1.195	(2.39)	0.889	(2.04)	0.170	(2.59)	72.9	2.89
0.7	1.346	(2.37)	0.939	(2.24)	0.170	(2.85)	78.5	2.92
0.8	1.482	(2.33)	0.989	(2.44)	0.169	(3.05)	83.4	2.93
0.9	1.606	(2.29)	1.036	(2.62)	0.167	(3.22)	87.8	2.93
1.0	1.720	(2.24)	1.080	(2.78)	0.164	(3.38)	91.8	2.93

which alternate in sign but decline geometrically in absolute size over time. Even if δ_2 is mis-specified, the inaccuracies in GLS estimates of α_4 are small. This should be contrasted with the least-squares estimates of α_4 which indicate the presence of very substantial upward biases. Thus the quantitative role of excess demand, as represented by quits, is probably seriously overstated by the least-squares fits. Secondly, the GLS calculations for t-statistics associated with the two price variables are positively correlated with the size of δ_2. Thus Donner's use of the higher values of δ_2 in five of the six price-expectations equations (with equation 6e as the exception) tends to make the acceptance of the price variables more likely. Finally, it is worth considering the consequences of choosing particular least-squares estimates of δ_2 when they are coincidentally accurate. If the least-squares estimate δ_2^2 is correct, then the associated estimates α_3^2 and α_5^2 are both too high by reference to the GLS results. If the alternative estimate δ_2^1 is correct, then there is no systematic pattern in the least squares estimates of α_3^1 , which are sometimes too low and sometimes substantially too high. For α_5^1 , the least-squares estimates for total manufacturing are reasonably close if δ_2^1 is correct but those estimates for durables and non-durables are low and high respectively, with more inaccuracies associated with the choice of the WPI variable as compared with the CPI one.

Conclusions

Some major conclusions of the earlier discussion are listed below.

(1) The wage-expectations model is rejected on the basis of evidence provided by our sample. In the context of quarterly bargaining groups and annual contractual revisions, the use of an annual expectational

lag is, perhaps, more appropriate but this modification to the adaptive expectations mechanism does not prove to be sufficient to justify retention of the wage-expectations model.

(2) The price-expectations model may be accepted although our inability to discriminate between distinct estimates of the adaptive expectations parameter makes this acceptance depend critically upon the unknown value of this parameter falling within a particular range. The relative success of the WPI variable as compared with that of the CPI variable requires more detailed consideration than we have been able to provide.

(3) Excess demand, as represented by quits, does appear to have a significance role in the determination of wages but the quantitative level of this linear influence is substantially overstated by the least-squares fits.

(4) Prior knowledge with respect to the possible values of the adaptive expectations parameter (as, for example, might be obtained from a series of detailed case studies) should be sought in order to clarify the bounds within which other structural parameters of the price-expectations model lie. In the absence of such information, some broad conclusions are possible but these are clearly insufficient if the wage relation is to provide an adequate basis for the formulation of governmental economic policies.

(5) The Yule-Slutsky effect, which was cited but subsequently ignored by Donner, indicates the need for careful investigation of the institutional framework of the labour market especially with respect to the contractual rigidities and intertemporal changes in bargaining patterns.

It can be shown that a failure to recognize this framework leads to biases due to the omission of appropriate variables and the presence of autocorrelated errors.

Footnotes

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1. "Labour Turnover, Expectations and the Determination of Money Wage Changes in U.S. Manufacturing", *The Canadian Journal of Economics*, Vol. 5, No. 1, February 1972, pp. 16-34.

2. Donner, p. 30.

3. See Marc Nerlove, "On Lags in Economic Behaviour", Report 7109, University of Chicago, p. 18, for a clear statement of the origins of this usage and subsequent developments. An interesting discussion of instability in expectations generation is provided by Otto Eckstein, *The Inflation Process in the United States*, a study prepared for the use of the Joint Economic Committee of the U.S., February 1972.

4. Donner, pp. 20-23.

5. These equations should be compared with those for equations (8), (11) and (14) of Donner's Table II, p. 27. We attribute the small differences either to our use of double precision or to slight changes in the treatment of the common data. Donner does not present any estimates which are comparable with those of Table 1(B).

6. These equations should be compared with those for equations (9), (10), (12), (13), (15) and (16) of Donner's Table II, p. 27. He does not present any estimates which are comparable with those of Table 2(B).

7. Donner, p. 30.

8. L. M. Koyck, *Distributed Lags and Investment Analysis*, (North-Holland, 1954), chs. 2 and 3.

9. G. L. Perry, *Unemployment, Money Wage Rates and Inflation*, (Cambridge, Mass., 1966), pp. 30-31.

10. S. W. Black and H. H. Kelejian, "The Formulation of the Dependent Variable in the Wage Equation", *Review of Economic Studies*, Vol. 39, January 1972, pp. 55-59.

11. "Quarterly Models of Wage Determination: Some New Efficient Estimates", *American Economic Review* (forthcoming) and "Implications for Estimation of Conventional Specifications in Empirical Studies of Wage-Determination", (Institute for Economic Research, Kingston, 1971, Discussion Paper No. 37B). For a critical attack on this approach see "Wage Determination: The Use of Instrumental Assumptions", *International Economic Review* (forthcoming).

12. See Rowley and Wilton, "Temporal Spillover and Autocorrelation in Some Aggregative Models of Wage Determination", (Institute for Economic Research, Kingston, 1972, Discussion Paper No. 82).

13. In a curious comment (footnote 23, p. 26), Donner mentions the over-determination of α_2, which is not actually overdetermined, without being seemingly aware of the similar over-determination of both α_5 and δ_2 and of the inevitable problems that arise as a consequence of this over-determination.